

REMARKS

I. Introduction

In response to the pending final Office Action, Applicants have amended claim 1 to further clarify the subject matter of the present disclosure. Support for the amendment to claim 1 may be found, for example, on page 3, lines 1-21 and page 14, lines 1-3 of the specification. No new matter has been added.

A Request for Continued Examination (RCE) is being filed concurrently with this Response.

Applicants respectfully submit that all pending claims are patentable over the cited prior art for the reasons set forth below.

II. The Rejection Of Claims 1-9 Under 35 U.S.C. § 103

Claims 1-9 are rejected under 35 U.S.C. § 103(a) as unpatentable over Matsuba et al. (WO 02/035554, hereinafter Matsuba). Applicants respectfully submit that Matsuba fails to render the above cited claims obvious for at least the following reasons.

With regard to the present disclosure, amended independent claim 1 recites an electrically conductive paste to be sintered comprising main components including a metal powder, a glass frit, and an organic vehicle, wherein the metal powder comprises spherical particles (A) having an average primary-particle diameter of 0.1 to 1 μm and spherical particles (B) having an average primary-particle diameter of 50 nm or less, and the content of spherical particles (A) is in the range of 50 to 99 wt % and the content of spherical particles (B) is in the range of 1 to 50 wt % relative to the total amount of metal particles; the content of the glass frit is in the range of 0.1 wt % to 15 wt % to the total amount of the glass frit and the metal powder; the conductive

paste exhibits a volume resistivity of $3\ \mu\Omega\cdot\text{cm}$ or less at a sintering temperature of $500\ ^\circ\text{C}$; and
the organic vehicle contains a cellulose resin or an acrylic resin.

Features of the present disclosure include a conductive paste which is sintered to form a product such as an electric circuit that exhibits a volume resistivity of $3\ \mu\Omega\cdot\text{cm}$ or less at a sintering temperature of $500\ ^\circ\text{C}$. The paste includes smaller spherical particles having an average diameter of $50\ \text{nm}$ or less, larger spherical particles have an average diameter of 0.1 to $1\ \mu\text{m}$, an optimization of the ratio of larger and smaller particles and an optimization of the glass frit content. As a result of these features, a paste that forms a highly-conductive electric circuit can be made.

Matsuba discloses a conductive paste which uses a thermosetting resin or the like as an organic binder. The binder resin remains even after curing because the paste is cured at relatively low temperatures (i.e., 200 - $220\ ^\circ\text{C}$). As a result, the volume resistivity of the cured paste is high. As a result, all of the Examples shown in Matsuba are over $3\ \mu\Omega\cdot\text{cm}$. For instance, Examples 2-1 is $45\ \mu\Omega\cdot\text{cm}$ and Example 2-2 is $60\ \mu\Omega\cdot\text{cm}$. The best example of Matsuba, Example 1-2, is $6.5\ \mu\Omega\cdot\text{cm}$, more than 2 times greater than the claimed range. Accordingly, it is clear that Matsuba does not disclose the electrically conductive paste of amended claim 1 of the present disclosure. As such, the design method of Matsuba for determining the particle size of conductive particles can not be simply applied to a sintering-type conductive paste, since the organic binder would be decomposed and removed in the sintering process. Moreover, the sintering-type paste needs to contain glass frit which is an inorganic binder, because the glass frit, the content or particle size, influences the properties of volume resistivity of the conductive paste.

Furthermore, Carroll does not remedy this deficiency. In Carroll, the examples provided in Table 6 in which the pastes were fired at temperatures of 610 °C and 660 °C have electrical resistivities of 4.6 $\mu\Omega\cdot\text{cm}$ and 5.4 $\mu\Omega\cdot\text{cm}$, respectively. Although it is alleged that Carroll discloses a glass powder added to the paste to provide a thick film which adheres the metal particles to the substrate, the present claims cannot be derived by merely optimizing the glass frit content. Increasing the glass frit increases the adherence. However, it also increases the degradation of conductivity and the occurrence of cracks derived from residual stress in the case of a thick coated film. Thus, as the present disclosure shows, in order to balance the properties of conductivity, processability to form a thick film, and adhesion to substrates, furthermore in order to obtain a paste with high conductivity at low-temperature sintering, it is necessary to consider the various parameters such as optimum particle diameter of the conductive particles, the compounding ratio of two different sizes of conductive particles, and the content of the glass frit. As neither Matsuba nor Carroll discloses this, it is clear that the cited prior art fails to disclose claim 1 of the present disclosure.

In order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. As is clearly shown, Matsuba and Carroll do not disclose an electrically conductive paste to be sintered comprising main components including a metal powder, a glass frit, and an organic vehicle, wherein the metal powder comprises spherical particles (A) having an average primary-particle diameter of 0.1 to 1 μm and spherical particles (B) having an average primary-particle diameter of 50 nm or less, and the content of spherical particles (A) is in the range of 50 to 99 wt % and the content of spherical particles (B) is in the range of 1 to 50 wt % relative to the total amount of metal particles; the content of the glass frit is in the range of 0.1 wt % to 15 wt % to the total amount of the glass frit

and the metal powder; the conductive paste exhibits a volume resistivity of $3\ \mu\Omega\cdot\text{cm}$ or less at a sintering temperature of $500\ ^\circ\text{C}$. Accordingly, Applicants submit that Matsuba and Carroll do not render claim 1 of the present disclosure obvious and as such, claim 1 is patentable and allowable over the cited prior art. Accordingly, Applicants respectfully request that the § 103(a) rejection be withdrawn.

III. All Dependent Claims Are Allowable Because The Independent Claim From Which They Depend Is Allowable

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819 F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claim 1 is patentable for the reasons set forth above, it is respectfully submitted that all pending dependent claims are also in condition for allowance. As such, Applicants respectfully request that the § 103 rejection be withdrawn.

IV. Conclusion

Having fully responded to all matters raised in the Office Action, Applicants submit that all claims are in condition for allowance, an indication of which is respectfully solicited.

Application No.: 10/531,697

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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